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# DESIGNING INTRA- AND INTER-ORGANIZATIONAL BUSINESS PROCESSES WITH WEB SERVICES

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## Abstract

*More flexible and agile Information Technology (IT) architecture is needed by a firm to respond to dynamic and competitive business environments. Web Service, which is defined as a software construct that exposes business functionality over the Internet, is considered to be the next vision to provide not only new IT architecture and strategies for enterprises, but also a technological basis for design/redesign of business processes. This research proposes a framework and methodology to design business processes with Web services. A formal model, which reflects strategic, economic, and structural perspectives, to identify and evaluate alternative Web services portfolio in business processes is proposed. The objective of this research is to provide a comprehensive and theoretical formulation for Web services to design/redesign business processes and business networks.*

**Keywords:** IT architecture, business processes, Web services, modularity, flexibility

## Introduction

The modern business environment is becoming more uncertain, more inter-networked, and more globally competitive. To survive in these turbulent circumstances, a firm needs to respond to external stimuli promptly and appropriately. Information technology (IT) can help firms to succeed in these complex business environments. For the last couple of decades, IT has been considered as a competitive weapon (Ives and Learmonth 1984, Porter and Millar 1985, Bakos and Treacy 1986) and a tool for reshaping organizations (Keen 1991). IT has helped firms in improving business efficiencies, strengthen their strategic positions, and link business partners directly. Recent developments in Information Technology – especially, the Internet – have brought the era of electronic business (e-business). This new age requires firms to dramatically change their way of doing business (Hoque 2000), their business strategies, and the structure of their organizations (Drucker 1988, Jarvenpaa and Ives 1994).

Many middleware technologies such as Java RMI (Remote Method Invocation), CORBA (Common Object Request Broker Architecture), Microsoft DCOM (Distributed Component Object Model), etc. have been proposed to resolve the problems of information systems (IS) integration and distributed enterprise IT architecture development. However, these technologies have not been very successful because they are complex, difficult to implement, and they do not support ubiquitous standards (Gokhale et al. 2002, Hagel 2002). New technologies, which are simple, open, and supports distributed architectures, are needed to overcome the weaknesses of the current middleware technologies.

Web services are considered to be the next vision to provide new IT architecture and strategies for enterprises. Hagel and Brown (2001) assert that the age of proprietary IS has come to an end, and the age of shared services is arriving. According to their argument, the core technology of the age of shared services is Web services. Web services promise enterprises to reduce the cost of conducting business, to deploy solutions faster, and to create new business opportunities (Kreger 2001). The Web services architectures are based upon the open Web standards such as HTTP (Hyper Text Transfer Protocol) and XML (eXtensible Markup Language). They also support multiple computing platforms, business integration within and between organizations, and complement traditional middleware technologies. Web services have a potential to offer solutions for building a more flexible and agile IT architecture, which can be used for integrating heterogeneous applications across enterprises. Since IT architectures needs to support design of agile business processes, Web services can be a technological basis for designing businesses processes.

This research develops a framework and methodology to design business processes with Web services. Since Web services are expected to provide efficient and flexible IT architectures for managing and integrating business processes, it is necessary to discuss how Web services can enable design of Business Processes. Even though web services standards are well established and many consortiums and organizations have proposed business process modeling standards, there is no systematic and normative approach to apply Web services to redesign business processes. This study proposes a formal model, which reflects strategic, economic, and structural perspectives to identify and determine a Web services portfolio in business processes, and then evaluates the solutions with a variety of criteria. The objective of this research is to provide a comprehensive and theoretical formulation for Web services to redesign business processes and business networks.

## Web Services: An Overview

A Web service is a software component, which delivers a specific functionality. The functionality is encapsulated, such that the implementation cannot be seen from outside. Only the interfaces are exposed so that Web services can be used from anywhere in the Internet. This feature dramatically enhances the reusability of Web services. In addition, Web services are distributed over the Internet and uses open standard protocols like HTTP and XML. The use of ubiquitous and open standard makes Web services different from the traditional middleware technologies. The services can be accessible from any platform and anywhere. Thus, the vendor lock-in effect (Shapiro and Varian 1999), which is a serious problem with the old middleware technologies, is not an issue. The multi platform support facilitates the integration of legacy systems. Finally, the paradigm of Web services change the procurement of IS products and services significantly. It eliminates the installation process of software, because adopting Web services are totally different from buying software packages. If certain functionalities are required by the organization, it can just rent services like telephone and utility services (Hagel 2002). Web services change software components from products to services (Meyer 2001). Thus, Web services, can become a vehicle for the outsourcing of IS Development.

## Characteristics of Web Services Architecture

The basic component of Web services is a service. Once a service provider creates a service, it can be served to multiple clients. If a client needs a certain functionality to be satisfied, a service provider can deliver it over networks as a service. Thus, the architectural concept behind Web services is a service-oriented architecture (SOA) (Burbeck 2000). Web services promote a real-time SOA (WebCollage 2001), and Web services are a practical implementation of SOA (Sleeper and Robins 2002). Formally, SOA is defined as “a model in which small, loosely coupled pieces of application functionality are published, consumed, and combined with other applications over a network” (Sleeper and Robins 2002, p.7).

Sleeper and Robins (2002) identify four major pillars of Web services architecture: (1) distributed, (2) loosely coupled, (3) standard-based, and (4) process-centric. Hagel (2002) discusses technological and business challenges of Web services like (1) distributed centers of control, (2) diversity of technology platforms, and (3) dynamic environment that the Web services architecture should respond to. He categorizes four broad principles such as (1) simplicity, (2) loose coupling, (3) heterogeneity, and (4) openness that the Web services architecture should contain in order to resolve those challenges. Fremantle et al. (2002) also explain the attributes of Web services by describing the Web aspects of the Web services. Their attributes include Web-based protocols, interoperability, modularity, availability, simple description, implementation-independence, and published. Ratnasingam and Pavlou (2002) compare Web services with traditional business to business (B2B) applications like electronic data interchange (EDI). Because the Web services are built on the Internet and use open standards, they are open, flexible, decentralized, unmonitored, and shared applications rather than proprietary, centralized, and fixed.

In this research, we will focus on modularity and process-centric characteristics of Web services. Web services are inherently modular, and the modularity is closely related to design issues of Web services such as how to design and develop appropriate modules of Web services for IT architecture in an enterprise. Modularity is also connected to a loosely coupled and flexible IT architecture. Another characteristic, process-centric, identifies the part of business IT architecture that is directly related to the Web services design. The characteristic of process-centric tells us that Web services can be a promising tool for BPR. Thus, we understand basis of why business processes are important to Web services and how Web services can be designed to achieve more effective business processes.

## The Framework

We will review business process redesign (BPR) literature to highlight several BPR procedures and propose the conceptual framework for redesigning business processes by embedding the Web services architecture.

### *Business Process Redesign (BPR)*

Officially, BPR was initiated in the academic literature in 1990 with two seminal articles: Davenport and Short (1990) and Hammer (1990). Davenport and Short (1990) emphasize the role of IT in redesigning business processes. They insist that there is a recursive relationship between IT capabilities and BPR such as IT can support BPR, and BPR can be achieved with the help of IT. Hammer (1990) argues for more radical changes in transforming business processes. He strongly asserts process obliteration instead of process automation. This radical point of view requires an organization to have top-down leadership, IT enablement, and employee empowerment to conduct successful BPR (Hammer and Champy 1993). The principles of BPR are easy to understand, so BPR has been considered as a magic bullet to guarantee organizational success. However, the survey report about BPR projects shows that 85 percent of BPR projects failed because the execution of BPR is so difficult (Harari 1996). Enormous costs and the huge failure rate of BPR projects make organizations wary of establishing BPR projects.

The recent development of Web services changes people's perception toward BPM and BPR. Since BPM is considered to be one of the core components of the Web services architecture, it is expected that BPR will get more attention. Thus, it is worthwhile to review the prior literature of BPR to deal with business processes in the new context.

Many articles advocate a high level approach to conduct BPR (Davenport and Short 1990, Davenport 1993, Kettinger et al. 1997, Nissen 1998). All of these approaches include developing a business vision, diagnosing existing processes, redesigning new processes, and evaluating new processes. Table 1 presents procedures for BPR.

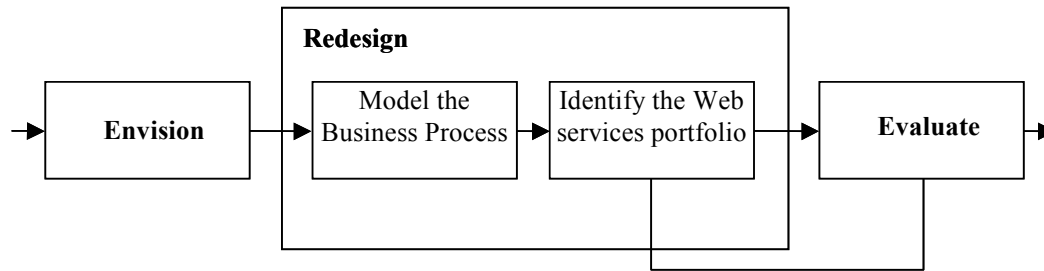
**Table 1. Procedures for BPR**

Authors	Procedure
Davenport and Short (1990)	<ol style="list-style-type: none"> <li>1. Develop business vision and process objectives (Prioritize objectives and set stretch targets)</li> <li>2. Identify processes to be redesigned (Identify critical or bottleneck processes)</li> <li>3. Understand and measure existing processes (Identify current problems and set baseline)</li> <li>4. Identify IT levers (Brainstorm new process approaches)</li> <li>5. Design and build a prototype of the process (Implement organizational and technical aspects)</li> </ol>
Davenport (1993)	<ol style="list-style-type: none"> <li>1. Identifying processes for innovation</li> <li>2. Identifying change levers</li> <li>3. Developing processes visions</li> <li>4. Understanding existing processes</li> <li>5. Designing and prototyping the new process</li> </ol>
Kettinger et al. (1997)	<ol style="list-style-type: none"> <li>1. Envision</li> <li>2. Initiate</li> <li>3. Diagnose</li> <li>4. Redesign</li> <li>5. Reconstruct</li> <li>6. Evaluate</li> </ol>

### *Framework*

Based on the previous BPR literature, we propose the conceptual framework for redesigning business processes with Web services (Figure 1).

This framework consists of three main phases: Envision, Redesign, and Evaluate. Most BPR articles indicate that BPR should be undertaken with specific visions and related objectives (Davenport and Short 1990, Davenport 1993, Kettinger et al. 1997). The envision phase identifies corporate strategies as inputs, and produces business processes to be redesigned. The envision phase is a prerequisite stage for redesigning business processes.



**Figure 1. Conceptual Framework for Redesigning Business Processes with the Web Services**

The redesign phase is generally comprised of modeling the business process and identifying the appropriate Web services portfolio for the business process. Once a business process is selected to be redesigned in the envision phase, we model the current business process to understand and measure it. This modeling stage provides a clear picture of how the business processes are interrelated and functions internally and externally. With this model of the business process, we need to identify the appropriate Web services portfolio. We will address this problem in terms of three perspectives: strategic, economic, and structural. Through this procedure, we can generate new design alternatives for the business process, which embed the Web services.

Finally, in the evaluate phase, the design alternatives are assessed with criteria such as performance, reliability, flexibility, etc. By using simulation techniques, we will simulate the set of design alternatives for the business process to determine which design alternative is most appropriate within the context. This research will mainly focus on the redesign and evaluate phase.

## The Model

We propose a formal model for identifying a Web services portfolio in the redesign phase. The systematic approach from three perspectives (strategic, economic, and structural) will be employed in the model. Before we build the model, we will discuss process modeling techniques for business process and workflow.

### Process Modeling

Traditionally, in the context of project planning and control, project process is represented by the network of activities. Since CPM (Critical Path Method) and PERT (Project Evaluation and Review Technique) were proposed in 1959, numerous researchers have studied the management of project by analyzing activity networks. The main research issues in project management are finding critical paths of activity networks, modeling time-cost trade-offs in deterministic activity networks, allocating resources evenly across activities, and modeling probabilistic activity networks (Elmaghraby 1977). The implications of this research stream are that the processes of project can be represented by activity network, and times, costs, and resources related to activities have been significantly considered to generate the optimal solutions for project planning and control. Additionally, in the field of IT research, process modeling has been developed related to BPR, coordination technology, and process-driven software development (Curtis et al. 1992). With the adoption of process automation, process modeling is an indispensable stage in BPR and workflow implementation. In this research, we focus on modeling processes in BPR and workflow with the help of traditional activity networks.

In general, a business process is defined as “a set of logically related tasks performed to achieve a defined business outcome” (Davenport and Short 1990, p.12). Workflow Management Coalition (WfMC) defines workflow as “the automation of a business process in whole or part, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules” (Allen 2000, p.15). According to these definitions, workflow is an automated business process, so workflow becomes one part of a business process.

There have been many techniques proposed to model business processes or workflows such as Petri nets (van der Aalst 2000, van der Aalst and Kumar forthcoming), Metagraph (Basu and Blanning 2000), Unified Modeling Language(UML) (Eriksson and Penker 2000, Castela et al. 2001), Process Activity Graph (PAG) (Datta 1998), and Dependency Network Diagram (DND) (Tillquist et al. 2002). Each technique has its own unique characteristics, so we will review these modeling techniques to compare their strengths and weaknesses.

### ***Related Literature to Develop a Formal Model***

Before we establish the formal model to identify the Web services portfolio within the business process, we review characteristics, which are closely related to the Web services architecture. In the previous section, we found that modularity and process-centric are critical features of the Web services architecture. In addition to these features, we argue that information technology (IT) outsourcing is another significant topic to understand the Web services model. In the Web services architecture, the service providers provide a service. Occasionally, the service providers can be inside the organization, however, mostly they are from outside the organization. Thus, the Web services model is quite closely related to IT outsourcing to satisfy an organization's needs. Since Eastman Kodak's outsourcing decision in 1989, IT outsourcing has been one of hot topics in information systems (IS) research and IS market in the last decade (Loh and Venkatraman 1992b). We expect that the Web services offer new opportunities to IT outsourcing research and market. Table 2 shows the IS literature areas which are related to the Web services architecture.

**Table 2. IS Literature Areas Related to the Web Services Architecture**

<b>IS Area</b>	<b>Related Fields</b>
Modularity	Loose Coupling Flexibility
IT Outsourcing	Core Competencies Transaction Cost Economics (TCE)
IS Integration	Inter Organizational Systems (IOS) Transaction Cost Economics (TCE)

### ***Toward the Model***

Based upon the literature review, three perspectives such as strategic, economic, and structural are determined to establish the model for identifying the Web services portfolio within business processes (Table 3).

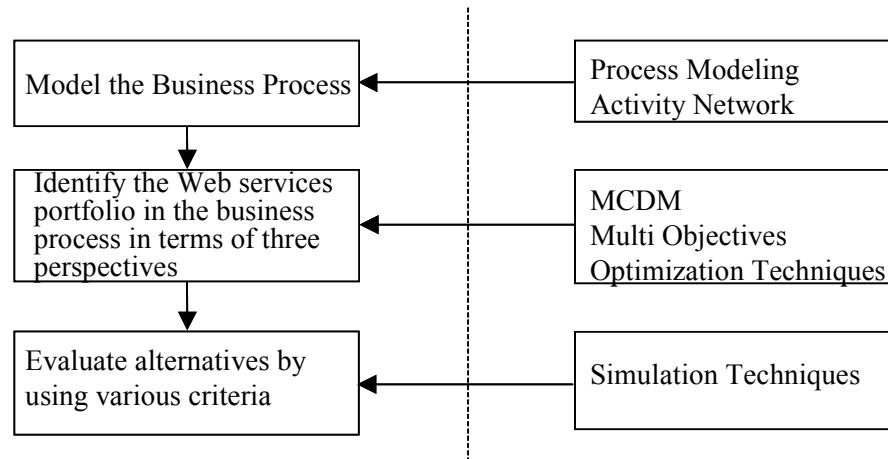
Strategic perspective is related to issues of IT outsourcing, organization design, and business network design. If certain business processes and activities generate core competencies for a firm, the firm wants to keep those processes and activities internal. Additionally, if certain activities are related to the part of interorganizational activities such as procurement, logistics, etc., those activities are likely to be developed or outsourced in the form of Web services because firms want to integrate their business processes with their business partners to operate seamless businesses. Thus, strategic perspective provides the broad plan of IT outsourcing and business network design. Economic perspective deals with the efficiency issues of IS development and IT outsourcing. It suggests a model that develops cost-effective, efficient alternatives for applying Web services within a business process. Production costs, transaction costs, time, resources, and risks are salient factors in this perspective. Finally, the objective of structural perspective is to provide a more flexible IT architecture for a certain business process. Several factors such as number of components, granularity, and coupling are important to maximize flexibility in the business process.

**Table 3. Three Perspectives for Identifying the Web Services Portfolio**

	<b>Strategic</b>	<b>Economic</b>	<b>Structural</b>
Goals	Find core activities Find edges for IOS	Minimize cost and risk Minimize time (duration) Allocate resources	Maximize flexibility Find the weakest linkages
Features	Core competences IOS	Production costs Transaction costs Time Resources Risks	Flexibility Loose Coupling

## Research Methodology

Currently, we are developing a specific formal model for BPR with Web services. We will use multiple-criteria decision making (MCDM) techniques to generate design alternatives of a business process which embeds Web services and simulation techniques for evaluating the alternatives. Figure 2 shows the outline of research methodologies.



**Figure 2. Outline of Research Methodologies**

## Contributions

This study offers the following specific contributions for IS researchers and practitioners. For IS researchers, this research

- Shows a new way for redesigning and integrating business processes by using Web services,
- Presents a systematic map of IS research areas that are relevant to future research in Web services,
- Presents critical factors for employing Web services in business processes from strategic, economic, and structural perspectives,
- Proposes a method for modeling business processes embedded Web services,
- Presents an evaluation and simulation procedure for business processes embedded Web services.

For practitioners, this research

- Shows Web services are a promising technology for redesigning and integrating business processes within and between organizations,
- Demonstrates the proposed model with real world cases.

## References

References are available upon request from author.